4 WATER SOURCE:

4.1 Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to rearing steelhead attributable to the water source:

4.1.1. Main River Pumps: Facility water is supplied directly from the adjacent Carmel River by two large submersible pumps. The pumps are installed approximately eight feet underground within a concrete gallery. River water flows into the gallery directly from the river through a ten-inch pipe connected to a large diameter intake screen in the middle of the river channel. The intake screen is constructed of wedge-wire mesh with 3/32-inch slot openings and sized to meet CDFG and NOAA-Fisheries screen criteria to protect salmonid fry. During operations the screen is checked and manually cleaned once per day. The screen is not fitted with a automatic cleaning device, though it is plumbed for an air-burst cleaning system. It is inspected and hand-cleaned once or twice daily. The screens' primary maintenance challenge is short periods of occasional clogging with filamentous algae, for which an air-burst cleaner is ineffective. After traveling through a cooling tower to reduce the temperature, up to two cubic feet per second (cfs) of river water is piped to the rearing channel and tanks before being discharged back into the river approximately 300 feet downstream of the inlet.

4.1.2. Back-up Pump: In addition to the two primary river pumps, a large, portable, agricultural pump was purchased in 2003 as part of the Facility's Interim Retrofit Project that addressed the possibility of future sediment loads from San Clemente Reservoir. This pump attaches directly to the intake screen via a 6-inch hose and delivers 500 gpm in back up mode. The water is pumped through a 6-inch PVC pipe directly to the cooling tower or through a sand separator.

4.1.3. Other Water Sources: At this time, there are no other water sources for the Facility, but two means of diverting water were previously investigated.

4.1.4. Gravity-Fed Intake: In 1992 during the early design phase of the project, the District investigated a gravity fed 10-inch pipeline for the Facility. In this concept, a screened water diversion would have been constructed and operated about ½-mile upstream of the Facility. No electrical power or primary pumps would have been needed for this proposal, but the option was denied by the California Department of Fish and Game (CDFG), as it would negatively impact steelhead habitats between the intake and discharge locations at low flows by reducing the streamflow.

4.1.5. CAW Tie-In: The original Facility plan included a tie-in to the CAW diversion pipeline that runs from the San Clemente Dam to CAW's

Carmel Valley Filter Plant. This was proposed as a backup source during periods when the primary intake at the Facility was inoperable. This option was sidelined after 1998, when the sand deposition and suspended sediment began to affect the viability of CAW's diversion at San Clemente Reservoir.

4.1.6. **Existing Quantity of Water Available for the Facility:** The quantity of water available in the Carmel River is adequate to supply the Facility. A portion of the supply is stored water from Los Padres Reservoir (LPR). At the District gauging station at Sleepy Hollow Weir, the mean monthly flows have ranged from minimums of 3.5 to 6.0 cfs to maximums of 14 to 234 cfs and averaged from 8 to 59 cfs (**Table 4-1**). Based on the mean monthly flows, the Facility 2 cfs diversion rate ranges from 3.4 to 25 percent of the streamflow. During critically-dry conditions, 1994 and 2007 Water Years, the diversion rate comprised 57 percent of the streamflow. However, the facility is engineered such that its outflow is returned to a pool immediately downstream of the diversion point, which naturally backwaters the river to within less than a foot of the intake, so it has no significant effect on streamflow.

Table 4-1

Mean Monthly Streamflow in the Carmel River at Sleepy Hollow Weir

June -November, Water Years 1994 to 2007 [1]

Year	June	July	August	September	October	November	December
1994	6.0	3.7	4.0	4.0	4.0	3.6	3.6
1995	66.6	22.5	8.9	8.4	8.8	9.0	23.5
1996	23.9	13.8	8.5	8.4	7.4	15.5	inc [2]
1997	10.4	6.1	6.1	6.2	4.5	11.5	71.7
1998	106.0	50.9	21.2	14.0	17.2	21.1	37.1
1999	29.8	10.7	6.6	7.1	6.5	8.3	8.7
2000	28.1	15.7	9.9	8.9	12.7	15.1	15.0
2001	20.0	11.9	7.4	7.5	6.9	11.4	129.0
2002	17.8	9.4	6.3	5.9	6.0	38.0	234.0
2003	39.8	19.9	11.9	9.7	7.8	8.0	39.9
2004	13.5	7.3	5.7	6.3	8.7	17.3	118.2
2005	47.5	22.5	15.5	11.1	9.7	9.2	67.3
2006	53.8	21.9	13.8	10.5	8.3	9.2	11.5
2007	7.5	4.3	3.7	3.5	3.7	3.6	4.3
MEAN	33.6	15.7	9.2	8.0	8.0	12.9	58.8
MAX	106.0	50.9	21.2	14.0	17.2	38.0	234.0
MIN	6.0	3.7	3.7	3.5	3.7	3.6	3.6

[1] Source: James, G. W. 1996, 1999, and 2004 and MPWMD website at: http://www.mpwmd.dst.ca.us/wrd/riverflows/riverflows.htm

[2] inc: Incomplete record for this month. Gaging station monitors low flow releases from San Clemente Reservoir.

4.1.7. **Existing Quality of Water Available for the Facility:** In 1992, the District expanded its surface water quality monitoring program to include the Sleepy Hollow Weir (SHW) at RM 17.1. Since 1992, District staff has measured the following chemical parameters on a semi-monthly basis (twice per month):

1. Water temperature
2. Dissolved Oxygen
3. Carbon Dioxide
4. pH
5. Specific Conductance

The District observed physical conditions pertaining to water color, odor and turbidity during the semi-monthly measurements. After an unusually warm period in 1995, the District expanded the semimonthly water temperature sampling program and installed a continuous recording temperature sensor at SHW in 1996. Beginning in December 2002, the District added turbidity measurements to the list of quantitative water quality parameters. **Tables 1** to **11** (**Appendix 4-A)** and **Figures 4-1 to 4-5** summarize the data for the period from 1997 to August 2007.

Generally, physical and chemical characteristics of the water supply are suitable for rearing juvenile steelhead:

- **Dissolved Oxygen –** Since 1997, dissolved oxygen varied from 8 to 15.5 mg/l during semi-monthly measurements (**Figure 4-1**)**.** Measurements from the lower end of this range less than or equal to 9 mg/l usually correlated with warmer water temperatures and yielded saturation levels above 90%

- **Carbon Dioxide –** Carbon dioxide ranged from 5 to 30 mg/l with 95% of the measurements in the 5 to 10 mg/l range (**Figure 4-2**). Exceptions within the high end of the range occurred in July-September 2003 and correlated to the initial drawdown of San Clemente Reservoir to meet the California Department of Water Resources requirements for reducing the risks from a seismic failure at San Clemente Dam. Levels of CO_2 above 10 mg/l are problematic for juvenile steelhead because of its effect on fish respiration. Higher CO_2 concentrations interact with high water temperature and dissolved oxygen to limit the amount of oxygen extracted for blood. If CO_2 persist at high levels, the reduced respiration limits fish activity, growth and normal behavior.

- **Conductivity** -- Conductivity measurements ranged from 129 to 445 microsiemens per cm (uS/cm) with the highest levels typically during the low-flow season (**Figure 4-3**). In the Carmel River Basin, this conductivity range is approximately equivalent to 104 to 360 mg/l of total dissolved solids and within the range suitable for hatchery water supplies (Piper, 1982).

- **Turbidity –** Prior to 2003, the District observed turbidity and rated it on a qualitative scale as none, slight, moderate and high. In response to potential increases in turbidity associated with the San Clemente Dam Interim Seismic Retrofit Project, the District began semi-monthly measurements in December 2002. As shown in **Figure 4-4,** turbidity levels typically increased during the early summer through fall period, coincident with current operations to

Figure 4-1

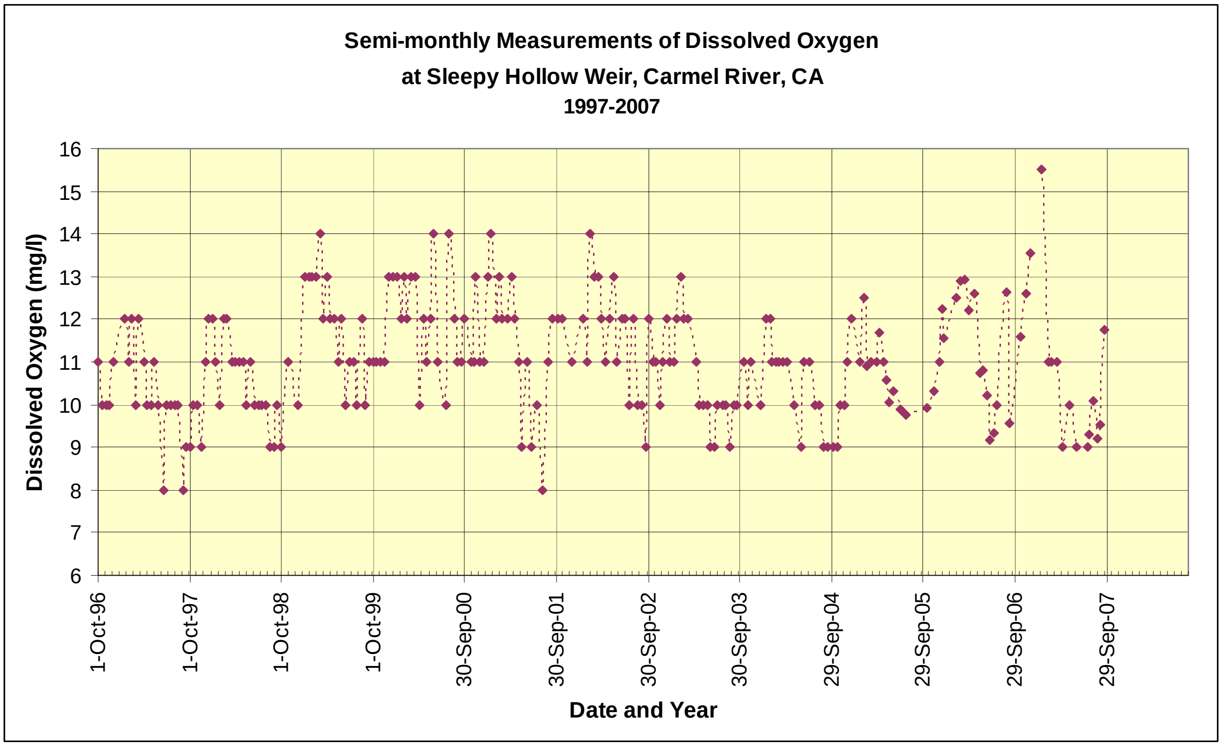


Figure 4-2

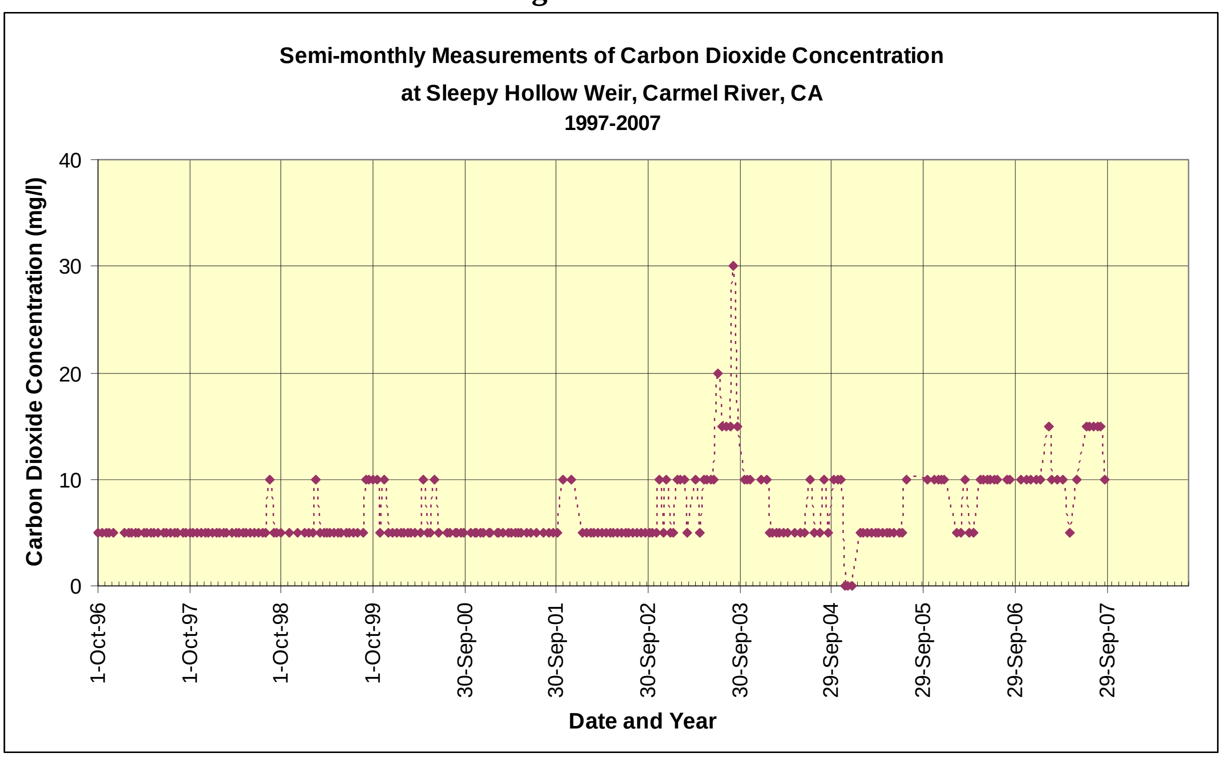


Figure 4-3

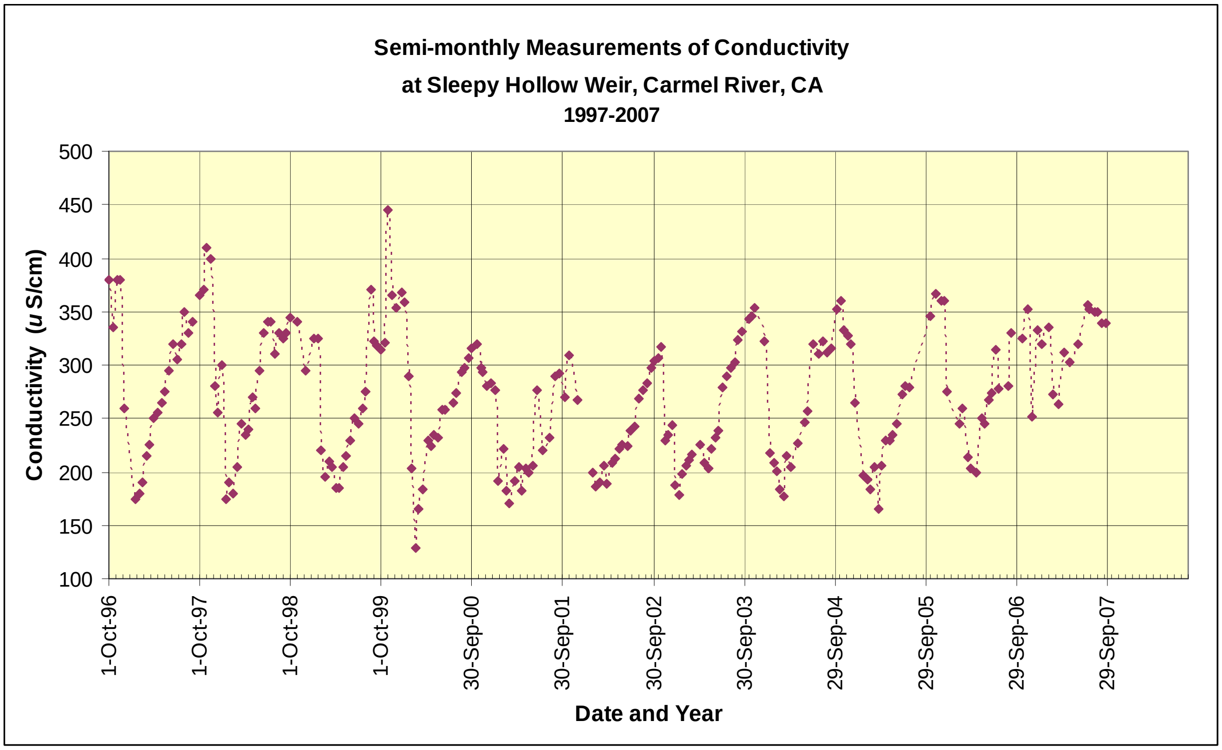


Figure 4-4

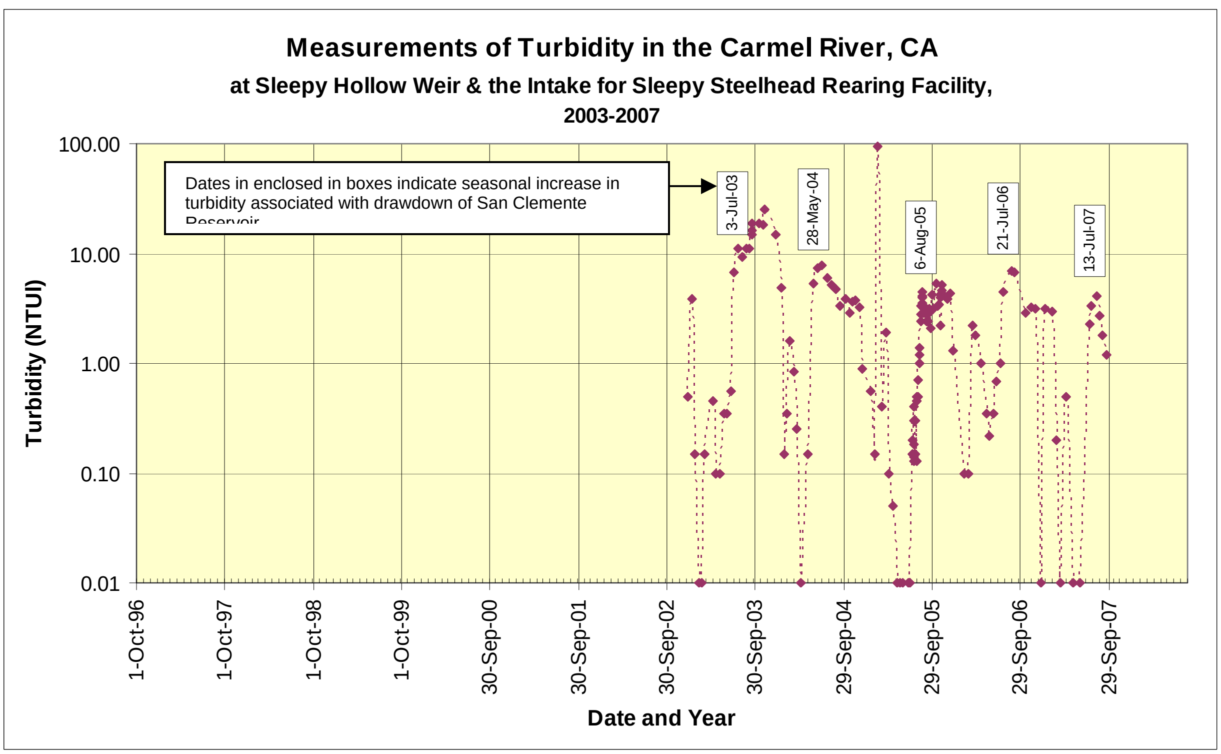
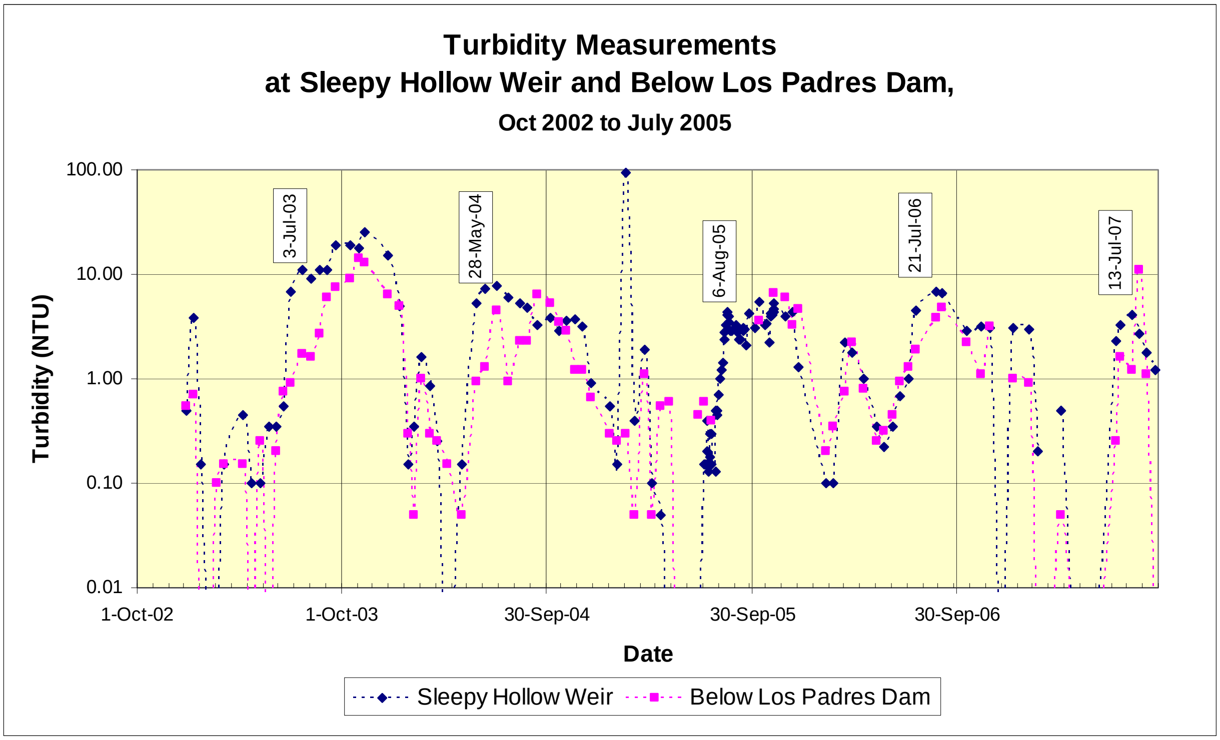


Figure 4-5



lower the water surface elevation in San Clemente Reservoir. It appears that turbidities increased to higher levels and persisted for longer periods in 2003 and 2004, as compared to the most recent year 2007. As shown in **Figure 4-5,** turbidity levels at the Sleepy Hollow Weir are often higher than turbidity measured below LosPadres Dam. The pattern at Sleepy Hollow results from mobilization and transport of fine suspended sediments through the inundation zone, as the water surface elevation is drawn down and suspension and passage of the finest fraction is released through the dam ports.

Regarding its effect on fish at the Facility, the turbidity is usually low enough (<5 NTU) to not interfere with normal fish behavior, feeding, metabolism and growth. In some instances, where the levels persist above 5 NTU for several weeks, the behavior of juveniles could be affected, but these impacts are not expected to be a major problem. Turbidities in the 10-25 NTU range, as were common during the initial year of drawdown at San Clemente Dam (2003), are more problematic and have increasingly deleterious behavioral and physiological effects including avoidance behavior, breathing interference, reduced reaction times, changes in territoriality, reduced foraging, and reduced growth. Separate from effects on individual fish, the suspended sediments correlated with turbidities in the 5-25 NTU range, settle out in the rearing channel, thereby reducing habitat complexity, reducing primary productivity, reducing aquatic insect/food production, and filling pore spaces throughout the channel and in biological filters. A synopsis of these low-level turbidity effects is itemized in **Appendix**

4-B, per a review by Bash, Berman and Boltman (2001).

- **Water Temperature** As mentioned earlier in Section 5.5, water temperatures are often outside the suitable range for rearing juvenile steelhead. **Figures 1-11** in **Appendix 4-A** show plots of seasonal water temperature at the Sleepy Hollow Weir for the period 1997-2007. Close examination of the seasonal trends show warming and cooling patterns typical of coastal streams in this part of California, but the maximums and mean temperatures during the summer months historically range above levels normally found at this elevation in steep, mountainous canyons. Notably, the extent and duration of temperatures during the warmest period coincides with the period that juvenile steelhead are reared at the Facility (**Table 2**). Mean daily temperatures exceeded 65 °F on 54 to 142 days per year during the 1997-2007 and maximum daily temperatures exceeded 70°F on 20 to 125 days. Based on experience in 1997 and 1999, this temperature regimen, left untreated, places severe stress on juveniles, causing loss of body condition, susceptibility to disease, poor growth and in extreme cases, near complete mortality. On the positive side, the seasonal thermal regimen appears to be cooling, as indicated by the reduction in number of days with means > 64 °F and with maximums >70 °F (**Figure 4-6**). This pattern probably has resulted from recent changes in reservoir operations associated with the San Clemente Reservoir Drawdown project. Since 2003, the influence of the reservoir on heating river water has gradually diminished as CAW no longer fills the Reservoir during spring months and water level is drawn down during the summer period; thereby reducing the water surface area in the old inundation zone. The morphology of the inundation zone is also changing, becoming more like a stream with a defined flow channel.

- **Treatment of High Temperature** As described in Section 5, the District conditions incoming water with a cooling tower, primarily to reduce water temperatures, but the tower has the added benefit of stripping CO_2 and saturating the effluent with dissolved O_2. Water flows through the tower continuously during summer months with the tower fan turning on automatically when influent temperature exceeds 59 °F. Typically, the tower cools the water by a maximum 6-10 °F depending on river temperature and relative humidity (**Figures 4-7 and 4-8**).

  In addition to operation of the cooling tower, the quarantine tanks are fitted with thermostatically controlled chillers to reduce and control water temperature. In 2008, the District retrofitted the eight rearing troughs with filtration and chiller systems to control temperature and increase carrying capacity in these components.

Table 4-2

Summary of Water Temperature Exceedance and Duration Parameters in the Carmel River at Sleepy Hollow Weir, 1997-2007 [1]

Year	First Date with Mean Temp. > 65 deg F	Seasonal Duration (days with Mean Temp. > 65 dedF)	First Date with Maximum Temp. > 70 deg F	Seasonal Duration (days with Max. Temp > 70 dedF)
1997	15-May-1997	142	16-May-1997	125
1998	15-Jun-1998	86	13-Jul-1998	62
1999	14-Jun-1999	95	22-Jun-1999	78
2000	16-Jun-2000	96	16-Jun-2000	76
2001	21-May-2001	116	31-May-2001	87
2002	29-May-2002	102	30-May-2002	83
2003	inc [2]		inc [2]	
2004	3-Jun-2004	100	15-Jun-2004	87
2005	29-Jun-2005	66	5-Jul-2005	33
2006	17-Jun-2006	71	16-Jul-2006	20
2007	3-Jun-2007	54	14-Jun-2007	33

[1] Source: MPWMD data files;daily maximum and mean water temperatures based on hourly data recorded at Sleepy Hollow Weir Hamilton (2004) and Canning (1998).
[2] Inc; Temperature record incomplete for 2003 (ends May 19, 2003).

Figure 4-6

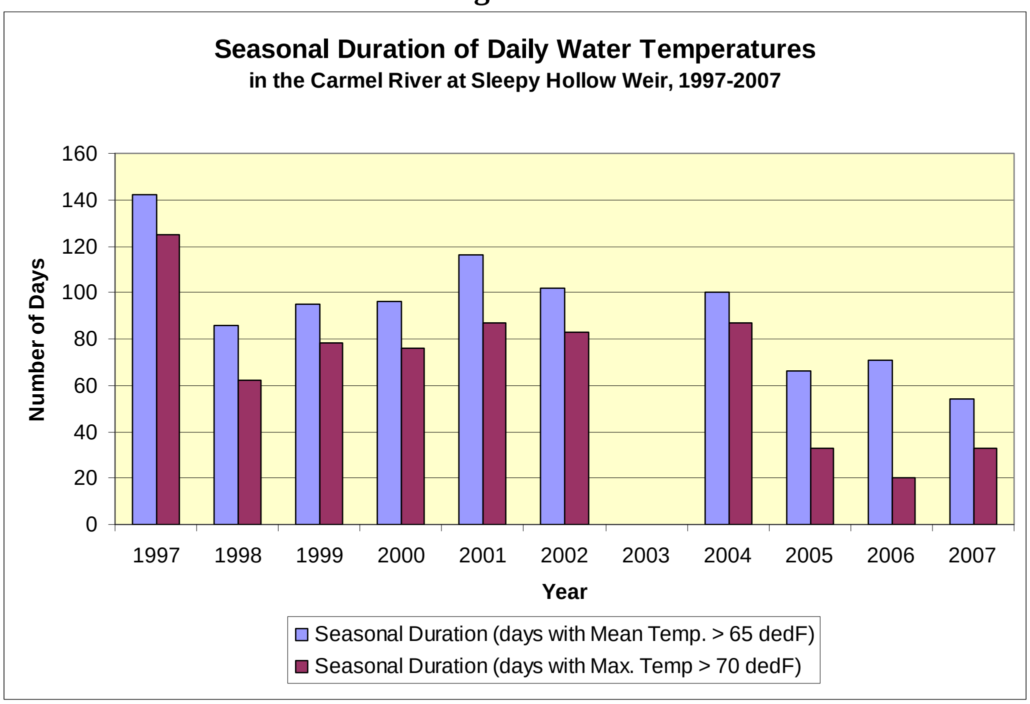


Figure 4-7

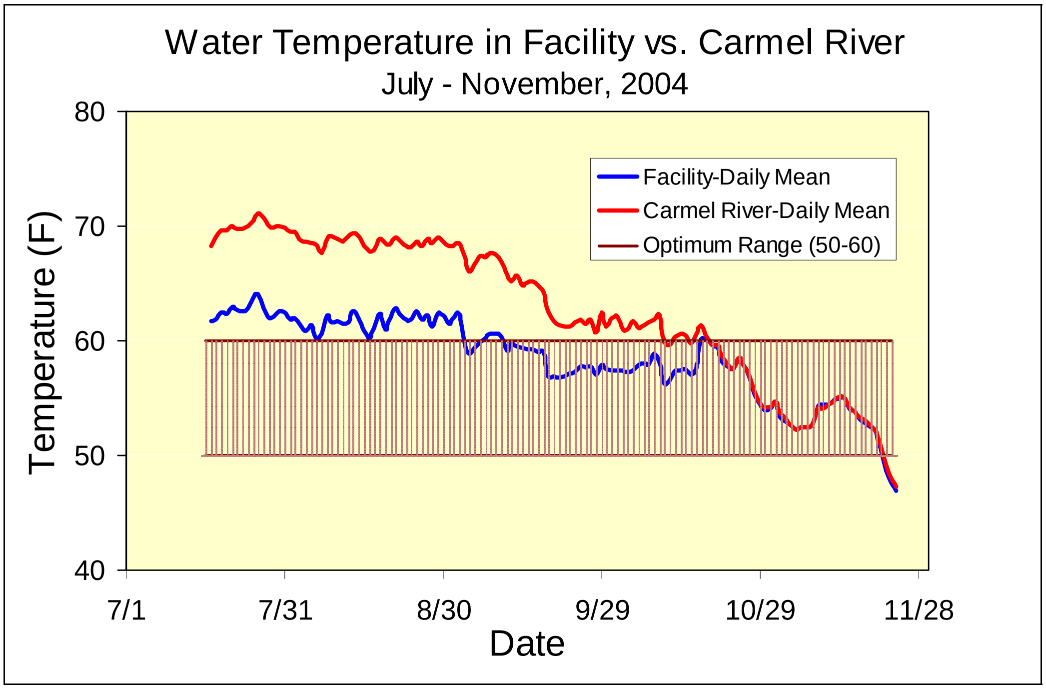
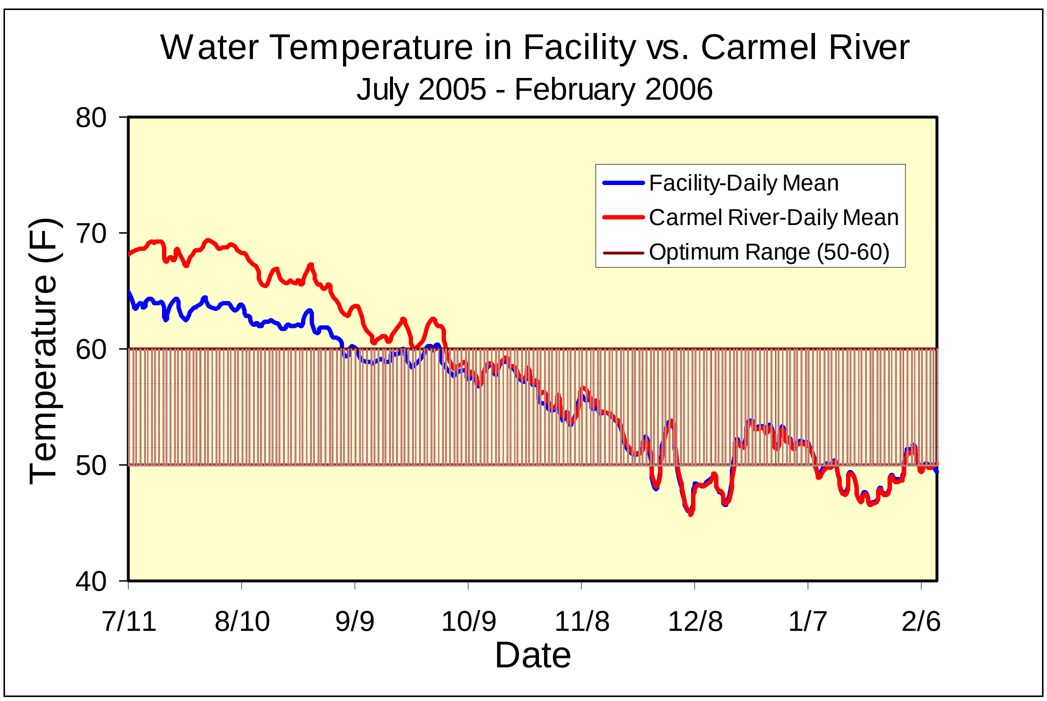


Figure 4-8



4.1.8. Other Known Constraints to Water Supply for the Facility: Two additional constraints may limit future suitability of a water supply for the Facility, including sediment transport and future loss of surface water storage in LPR. The following sections provide brief descriptions of constraints and potential solutions:

- **Sediment Transport** The future sediment transport regimen at the Facility water intake will substantially change in the near future. Basically, San Clemente Reservoir is nearly filled with sediment, and San Clemente Dam is a seismically unsafe dam. These two facts set the stage for major changes in sediment delivery to the diversion point at the Facility water supply intake. Currently, the California Division of Safety of Dams requires CAW to lower the reservoir level during spring months from elevation 525 to 515 feet, and to keep it at elevation 515 until the resumption of flows in the late fall/early winter. With this operation, the sediment deposited in the inundation zone during the winter becomes remobilized and transported into the small reservoir forebay, where some of it is released into the river channel below the dam. This material passes down the river as suspended or bedload particles and ends up at the Facility intake. Currently, the full potential of the river to transport sediment into the intake has not been realized because the reservoir still traps a significant fraction of the bedload, but in the near future the delivery will increase, once the forebay is filled with sediment.

  Figure 4-9 shows the predicted future sediment loading at the intake, ranging from 0.05 tons/day at 1 cfs to 50 tons/day at 100 cfs (Mussetter, 2002). Depending on timing of future flows, duration of the Facility operation season, and the selection of an alternative for retrofitting San Clemente Dam, the annual sediment deposition or intake of sediment is expected to range from approximately 35 to 200 tons per year (**Figure 4-10**). Considering the intake is a direct diversion, the entrainment of sediment on the order of 35 to 200 tons per year will cause frequent pump failures and jeopardize Facility operations during late-fall and winter months. To examine options for this problem, the District retained List Engineering Inc. to develop and recommend concepts for protecting the water intake system. List (2003) examined eight conceptual alternatives and recommended Alternative 8, with parallel buried concrete settling pits, a new river inlet, new pump housings, revised pumps and a new 10-inch water supply line (**Figure 4-11**). For reference the List Report is included as **Appendix 4-C**. Based on the feasibility report and future uncertainty about future sediment transport rates, the District decided to not pursue a complete retrofit of the Facility, but implemented an Interim Sediment Retrofit Project including new pump seals, an adjustable intake screen, a new emergency backup pump, and a sand filter to improve reliability. However, additional improvements are needed to protect the Facility against higher sediment delivery rates anticipated

Figure 4-9 [1]

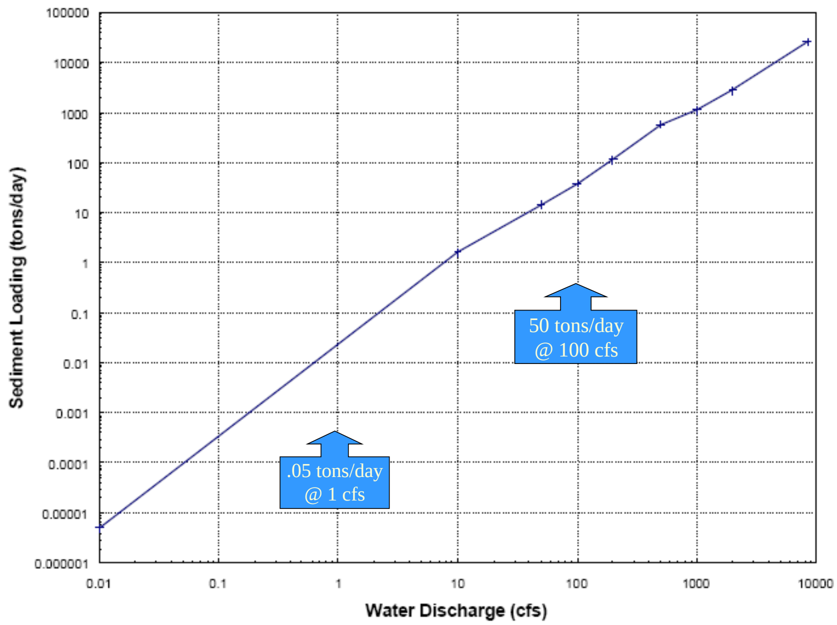
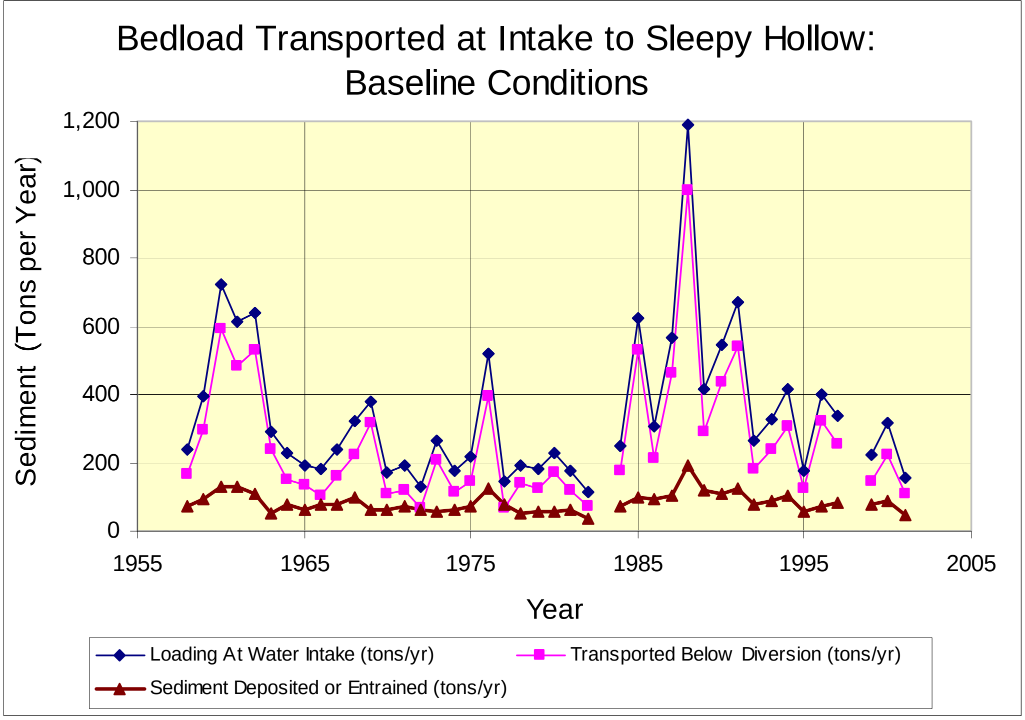


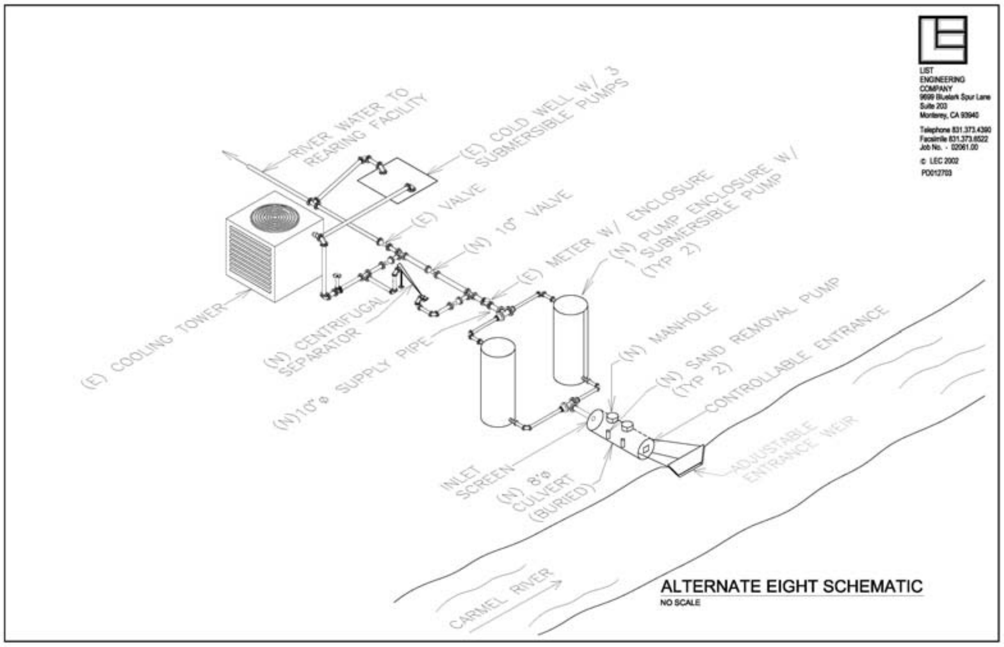
Figure 5.2. Baseline bed-material sediment rating curve for the upstream end of the project reach.

Figure 4-10 [2]



[1] Source: Mussetter (2002): Under baseline conditions the sediment delivered to reach below San Clemente Dam equals sediment delivered and transported through the inundation zone of San Clemente Reservoir.
[2] Estimates of sediment loading, transport and deposition are based on sediment transport capacity curve for the reach below San Clemente developed by Mussetter (2002) and the hydrologic record of daily flows from MPWMD CVSIM model, 1958-2001.

Figure 4-11 [3]



with the retrofit of San Clemente Dam and to increase flexibility and ease of replacing the pumps under emergency conditions. While some additional feasibility and design work is needed, the primary constraint to making further improvements is a lack of funding.

- **Loss of Surface Water Storage in Los Padres Reservoir:** Currently, LPR captures and stores approximately 1,569 acre-feet of surface runoff during the wet season from November through May. During the dry-season, CAW releases a portion of the stored water, which flows past San Clemente Dam and into the lower Carmel River. The levels of streamflow listed in **Table 4-1** depend on the storage and release of water stored in LPR, which is gradually filling with sediment, in a similar fashion to San Clemente Reservoir. Depending on the rate of fill, the loss of storage in LPR will eventually jeopardize CAW's ability to augment natural flows, as listed in **Table 4-1**. Once this happens, the flows available for diversion at the Facility intake may not be enough to supply the Facility and provide a net positive flow in the 300-foot long pool between the diversion and the Facility discharge. This is expected to occur most frequently in dry and critically-dry Water Years, when natural inflows to LPR are below 2 cfs. Under these conditions, the basic Facility design and operations would need to be revised by reengineering and rebuilding the Facility to circulate a portion of the water supply so that the Facility can operate at a lower diversion rate or by developing a groundwater-based source of supply.

[3] Source: List Engineering, Inc (2003)

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4.2 Indicate risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of hatchery water withdrawal, screening, or effluent discharge:

The following risk aversion measures are used to minimize the take of listed natural fish:

4.2.1 **Water Intake Screen:** The intake screen is oriented parallel to normal river flow to avoid risk of impingement, an approach velocity of 0.33 feet per second was used in calculating required screen area, and the wedge-wire was specified with a 3/32” slot-width dimension. Although the screen is not fitted with mechanical cleaners, staff checks and cleans the screen daily, or as often as needed to keep the slots open and clear. The Facility’s 24-hour automated monitoring and alarm system calls and warns off-site staff when water levels in the pump gallery decline or inflow decreases, which are reliable indicators that the screen is beginning to clog, and they respond 24-7 to clean it.

4.2.2 **Rotating Drum Screen:** The rearing channel is fitted with a horizontal-rotating drum screen with 3/32 openings to prevent fish from passing into the Facility from the river.

4.2.3 **Discharge of Facility Water**: The District operates the Facility under permitting authority of the Central Coast Regional Water Quality Control Board (RWQCB) in San Luis Obispo, California. The RWQCB requires specific conditions for operating including treatment of formalin, and monitoring water quality. A copy of the most recent water quality report to the RWQCB is attached as **Appendix 4-D**.